Phytogeographical Affinities of Forest Floras between China and Japan

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Abstract The flora of eastern China is the main part of Sino-Japanese floristic region. It shows by the analysis and comparison that the floristic relations of Eastern China with Japan are closer than that of northeast China with Korea. The similarity indices of genera and species of seed plants in the two regions are very high, being 72.6% and 43.3% respectively. The structure and species composition of broad-leaved evergreen forests in the two regions are also similar, in which there exist the corresponding communities, such as the forests of *Castanopsis carlesii, C. Sieboldii.*. Many plants in Easter China are nonspecific with those in Japan, e. g, *Cercidiphyllum japonicum, Magolia sieboldii, Nandina domestica* etc.. Though the genera *Ginkgo, Liriodendron, Sassafras* etc. existing now in China are extinct from Japan, their fossils have been discovered from the Tertiary Strata in Japan. It seems to indicate that the phytogeographical affinities between Japan and E. China was closer in ancient time than it is now; and both of the forest floras originated from one same flora. The flora in Japan did not evolve independently until it separated from Chinese continent and drifted to northeast in the late period of the Tertiary.
Key words: Phytogeogtraphical affinity, Forest flora, Eastern China, Japan

Introduction

Eastern China is one of the richest regions in plant life in the east Asia , its flora is the main part of Sino-Japanese floristic region, which has attracted the attention of many botanists both at home and abroad, such as Hu, H. H., Li, H. L., Steward, A. N. Wang, J. X., Wang, W. T., Wu, S. G., Wu, Z. Y. and Xie, G. W.etc. A number of papers dealing with Eastern Asian-Eastern North American phytogeographical relationships have been published. However, the floristic relations between eastern China and Japan have been rarely reported in detail until now.

Comparison and Analysis of Forest Floras

The floristic relationships between eastern China and Japan (especially the south part) are very close Eastern Considering the author's preliminary statistics, the similarity indices of families, genera and species of seed plants in the two regions are very high. Some aspects about the phytogeographical affinities can be analyzed as follows.

The endemic families of Eastern China common with Japan (7 families) are more than those common with Korea (2 families). There are 10 endemic families of Eastern Asia distributed in eastern China, including 3 endemic ones of China. None of these families occurs in northeast China. It shows that the floristic relations of Eastern China with Japan are closer than those with Korea and northeast China. Moreover, this point of view is testified by the analysis of genera and species as follows.

Generic distinct distribution phenomena of the two regions are the most prominent features. The similarity coefficient of spermatophyte's genera between Eastern China and Japan is 72.6%. There are 13 distribution types of these genera in Eastern China common with Japan or with Korea (Table 2). It shows from Table 2 that: The flora of Eastern China is related extensively with most parts of the world; the main distribution patterns of seed plants related with Japan or with Korea are the those of Eastern Asia, Pantropic and North Temperat Eastern The common genera of Eastern China with Japan are more than that with Korea. Specially, there are 66 genera of distribution in Eastern China, Japan and North America, for instance, *Magnolia, Illicium, Hamamelis, Phryma and Saururus* etc. The geological history seems to show that the formation of these distinct phenomenon results from the continental drift.

High endemism is another prominent feature in Sino-Japanese floristic region. It is not only rich in endemic families as shown in Table 1, but also it is abundant of ancient endemic genera and species. There are above 20 endemic genera in Eastern China, i. Eastern, *Ginkgo, Pseudolarix, Pseudotaxus, Monimopetalum, Changium, Speirantha, Brachystachyum* and *Changnienia* etc.. It shows the ancient of this flora that these genera are almost relic and monotypic ones. The endemic genera in Japan and Korea may be only 17 and 8 respectfully, and there are no common endemic genera in Japan and Ko-

rea. Obviously, this distinct distribution is caused by the geographical history changes. In addition, the common endemic genera in Eastern China and Japan of eastern Asia are three times of those in Korea(or northeast China) or in Taiwan.

Table 1. The distribution of endemic families of E. Asia in Sino-Japanese flora.

Family	Total No. of Genera / Species	E. China	Japan	Korea
Ginkgonaceae	1/1	+		
Cephalotaxaceae	1/9	+	+	+
Sargentodoxaceae	1/1	+		
Glaucidiaceae	1/1		+	
Nandinaceae	1/1	+	+	
Trochodendraceae	1/1		+	+
Cercidiphyllaceae	1/1	+	+	
Eupteleaceae	1/2	+	+	
Eucommiaceae	1/1	+		
Helwingiaceae	1/4	+	+	
Trapellaceae	1/2	+	+	+
Stachyuraceae	1/10	+	+	
Total	12/34	10	9	3

Table 2. Comparison of the distribution types of spermatophyte's genera of E. China common with Japan or with Korea.

Distribution Types	Genera Common with Japan	Genera Common with Korea
Cosmopolitan	81	65
Pantropic	131	79
Trop. Asia & Trop. America	11	4
Old World Tropics	37	15
Trop. Asia & Trop. Australia	37	13
Trop. Asia & Trop. Africa	18	6
Trop. Asia (Indo-Malesia)	41	21
North Temperate	154	123
E. Asia & N. America	66	40
Old World Temperate	49	34
Temperate Asia	7	3
C. Asia	1	0
E. Asia	137	75
Total	770	478

As regards the forest vegetation in Eastern China and Japan (specially south part), the structure and species composition of broad-leaved evergreen forests in the two regions are also similar, where exist the corresponding communities and species (trees) as shown in Table 3 and Table 4.

In point of species composition, common species between Eastern China and Japan are rich; the similarity coefficient of seed plant species in two regions is 43.3%. Furthermore, some corresponding species are so similar that they are taken for the same ones respectively. Many plants in Eastern China are conspecific with those in Japan, but not in Korea or in northeast China, Eastern. *Cercidiphyllum japonicum, Nandina domestica, Disanthus cercidifolius, Kirengeshoma palmata, Orixa japonica* etc.

Table 3. Comparison of composition (trees) of broad-leaved evergreen forests in eastern China and Japan

Eastern China	*Japan*
Castanopsis carlesii	*C. sieboldii*
Lithocarpus henryi	*L. edulis*
Cinnamomum camphora	*C. japonicum*
Machilus thunbergii	*M. japonica*
Distylium myricoides	*D. racemosum*
Camellia oleifera	*C. japonica*
Ternstroemia gymnanthera	*T. japonica*
Symplocos glauca	*S. theophrastaejolia*

In some corresponding species, it is still a question whether each should be treated as a single or divided into two species, such as *Cryptomeria japonica* (in Japan) and *C. fortunei* (in Eastern China). According to Li Linchu's study on the karyotypes and evolution levels of *Cryptomeria in* 1987 shows the karyotypes very similar, except that *C. japonica* is little higher in evolutionary level than *C. fortunei*. These close relationships of paralleled evolution are also connected with the similar climatic conditions (Table 5).

Differentiation and speculation are of great interest in biology. Though the forest floras of Eastern China and Japan had a common origin before the Quaternary, Japanese flora has evolved independently since these islands separated from the continent of southeast China and drifted to northeast. Therefore, there are many endemic elements occurring in Japanese flora, but these elements seldom occur in Korea. At the same time, some elements in Japan that are common in Eastern China differentiate gradually and evolve parallel, as shown in Table 6.

Table 4. Comparison of main corresponding species of endemic genera to E. Asia in eastern China and Japan

Japan	*Eastern China*
Cryptomeria japonica	*C. fortunei*
Euptelea polyandra	*E. pleiosperma*
Cercidiphyllum magnificum	*C. japonicum*
Stachyurus praecox	*S. chinensis*
Cardiandra alternifolia	*C. moellendorffii*
Platycrater serrata	*P. arguta*
Hosiea japonica	*H. sinensis*
Shibataea kumasaca	*S. chinensis*

Table 5. Comparison of mean monthly temperature and the mean annul rainfall between E. China and C.Japan

Area	Month												M. A. T*(°c)	M.A.R**(mm)
	1	2	3	4	5	6	7	8	9	10	11	12		
Tokyo	3.1	3.8	7.0	12.6	16.8	20.6	24.5	25.7	22.1	16.2	10.7	5.3	14.0	1610
Jiujiang	3.4	5.5	10.5	16.3	22.3	25.9	29.2	29.5	24.7	18.6	12.3	6.5	17.1	1407
Kyoto	2.7	3.2	6.4	12.2	16.9	21.3	25.6	26.3	22.4	16.0	10.0	5.0	14.0	1525
Hangzhou	4.3	5.2	9.4	15.3	20.4	24.7	28.3	28.1	23.8	17.9	12.1	6.4	16.3	1489

* M.A.T: mean annul temperature ** M.A.R: mean annul rainfall

Conclusions And Discussions

The flora of eastern China is the main part of Sino-Japanese floristic region. Based on comparison and analysis of the floristic elements, some aspects about phytogeographical affinities of the forest floras between Eastern China and Japan can be summarized as follows.

Table 6. Some conspecific differentiation in eastern China-Japan(not in Korea)

Japan	*Eastern China*
Disanthus cercidifolius	*D .c. var. longipes*
Dendrobenthamia japonica	*D. j. var. chinensis*
Cleistogens hackelii	*C. h. var. nakaii*
Hepatica nobilis	*H. n. var.asiatica*
Trema cannabina	*T. c. var. dielsiana*
Perilla frutescens	*P. f. var. acuta*
Lonicera chrysantha	*L. c. var. koehneana*
Arisaema sikokianum	*A .s .var. serratum*
Sedum drymarioides var. *doyoanae*	*S. drymarioides*
Cucubalus baccifer var. *japonicus*	*C. baccifer*
Urena lobata var. *japonicus*	*U. lobata*
Trachelospermum jusminoides var. *pubescens*	*T. jusminoides*
Galium trifidum var. *brevipedunculata*	*G. trifidum*
Peracarpa carnosa var. *circaeoides*	*P. carnosa*
Hieracium umbella var. *japonicum*	*H. umbella*
Ixeris chinensis var. *strigosa*	*I. chinensis*
Smilax riparia var. *ussuriensis*	*S. riparia*
Tripogon chinensis var. *coreensis*	*T. cinensis*
Trichosanthes kirilowii var. *japonica*	*T. kirilowii*

The phytogeographical relationship between Eastern China and Japan is much closer than that between Eastern China and Korea or northeast China. Moreover, the predecessors' views on the regionalization of Japan-Korea floristic province may be not rational. It seems that the Japanese flora should be delimited as independent province, because the floristic relations between Japan and Korea may be not closer than that between Japan and Eastern China; many endemic genera and corresponding species, which are common with Eastern China, occur in Japan (not in Korea); But there are almost no endemic genera in Japan common with Korea. It may suggest that either the flora of Japan or one of Korea has its own development in Eastern

The close relationship of Eastern China-Japanese flora have a long geographical history, which were established in the Tertiary, not in the plant dispersal after the separation from the continent or the drop of sea water level in ice age of the Quaternary.

The information of the geological history and ancient biology showed that Japan did connect with the continent of eastern China and not with Korea. Though the genera *Ginkgo, Liriodendron, sassafras* etc. existing now in eastern China are extinct from Japan, their fossils of leaves, fruits or seeds have been discovered from Japanese Tertiary Strata, which seems to indicate that the phytogeographical affinities between Japan and Eastern China was closer in ancient time that it is now; and both of the forest floras originated from one same flora.

Based on the common origin of the forest floras in Eastern China-Japan, and their high similarity and endemism, etc., it may be inferred on many evidence that the flora in Japan didn't evolve independently until it separated from Chinese continent and drifted to northeast in the late period the Tertiary.

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